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PHYSICAL FACILITIES AND CAPITAL REQUIREMENTS FOR ESTABLISHING A 200 ACRE FIELD NURSERY IN OHIO--1985

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ABSTRACT

Capital requirements for establishing a field nursery in Ohio were about $1,380,000 for a 200-acre facility having 175 acres of growing space, and 25 acres of production facilities, holding and field bed areas, and roads. Assuming a diversified product mix, the capacity for producing salable plants on an annual basis was 18,156 slow growing evergreens, 25,418 fast growing evergreens, 27,162 deciduous shrubs, 8,177 shade trees, and 11,954 ornamental trees. Capital requirements per salable plant capacity were $15.19 for slow growing evergreens, $10.85 for fast growing evergreens, $10.16 for deciduous shrubs, $22.73 for shade trees, and $23.07 for ornamental trees.

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INTRODUCTION

A cost model for production of crops representing five categories of field-grown production schemes in Ohio was developed. Physical coefficients are included so the information can be readily updated and so individual nurserymen can use the model as a standard against which to compare their own operation or planned operation. Information derived should provide a basis for decision-making for those evaluating the necessary physical and capital requirements in either establishing a new field nursery, expanding an existing field nursery or phasing out of field production.

Comprehensive cost models have recently been developed for container grown crops in U.S.D.A. Plant Hardiness Zone 6 (3), for field grown crops in U.S.D.A Plant Hardiness Zones 7 and 8 (1), and for field grown crops in U.S.D.A. Plant Hardiness Zones 5 and 6 (2). This paper presents physical requirements and capital expenditures for establishing a 200 acre field nursery in Ohio.

OBJECTIVES

The objectives of this study which are reported in this paper were to:

1. Model production systems that would accomodate a majority of the species of plants being field-grown in Ohio.

2. Analyze the important species of plants commonly grown in the field in Ohio, and assign each of them to one of the designated groups based on similarities of growing and production requirements.
3. Design physical facilities including land areas, land improvements, irrigation systems, and buildings for a commercial field nursery based on the model production system.
4. Determine capital costs for the above physcial facility.

MATERIALS AND METHODS

This paper is based on a firm synthesized using the conceptual framework of economic engineering wherein the "best proven practice" was included. It was synthesized based on Ohio (Figures 1 and 2). If specific items were required (i.e. depth of the well), coefficients were based on the Columbus, Ohio area. The complete model included developing an appropriate production cycle (Tables 1 and 2); schematic drawings of the physical layout, including buildings and irrigation system; lists of equipment and other items; a complete sequence by month and year of nursery operational steps beginning with land preparation and ending with loading the finished product for wholesale distribution (2).

Data for this study were obtained from wholesale nurseries and nursery suppliers in Ohio during the late Autumn and Winter of 1984 and the Spring of 1985. Price quotations obtained were

for the 1985 production season. The basic goals in synthesizing the production facilities were to minimize labor expenses, flow and movement of plant material and equipment, water runoff, maximize the number of salable plants and allow future expansion.

The nursery reported in this paper included 175 acres of growing space and 25 acres of production facilities, holding area, field bed area and roads.

Physical Plant and Equipment

Assumptions

Assumptions about the physical facilities and equipment can greatly affect its cost and thereby cost per salable plant. The authors included all items a nursery would typically require, thus the physical plant is probably more elaborate than many nurserymen would require. A nurseryman can easily eliminate or reduce items as required. However, it would require substantial effort to do the analysis on his own if they were not included.

Components

Land Improvement. For full utilization of the production facilities, holding area, and field-bed area; extensive grading, graveling, surface and underground drainage tiles were provided. Liner bed areas and general field production were tiled with 4" plastic tile, 30' on center, 46" deep using a herringbone design. For any area that heavy equipment may run over (shipping area and machine storage shed), #4 gravel was used. In other graveled areas, #8 grade was utilized. Although the cost of this

graveling operation is high, it is offset by greater efficiencies and dependability in the handling of plants, ability to reenter the areas after natural or artificial irrigation and reduction of soil erosion.

A pond was included even though it was assumed a well could be dug with sufficient regenerative water capacity. This was done to reduce the risk to plants while in holding areas in case of disruptions caused by repairs or electrical failure. An auxiliary take-off drive from the pump could be powered by a large 100 HP tractor for temporary irrigation.

Buildings. Permanent buildings were provided for the receiving of nursery stock/storage (50' x 40'), machinery repair/storage (50' x 40'), office space (20' x 20'), and restroom facilities (20' x 20').

Propagation facilities. For propagating the three classes of shrubs, a full 20' x 200' polyhouse would be utilized. This propagation area was equiped with a double polyethylene cover and heating equipment.

Overwintering facilities. Twenty polyhouses (20' x 200') were provided to overwinter 1/4 of a year's shrub harvest.

Machinery and Equipment. Purchase of new machinery and equipment was assumed for the model nursery to achieve true replacement costs. Many nurserymen may choose to buy used equipment, rent equipment or time-share some expensive items with other nurseries.

Irrigation system. Irrigation systems were designed to

minimize labor efforts and plant loss risk, yet provide sufficient irrigation capabilities to meet present and future water needs. The basic irrigation system was composed of four parts: water source, pumping equipment, inground irrigation pipe, and above ground irrigation pipe and materials.

The water source must have adequate reserves to meet maximum water needs and sufficient purity to meet cultural requirements. Because municipal water is expensive, especially if the production site is located far from a center of population; a well in conjunction with a constructed lake or a site situated near an open water source of high quality water would be desirable. Our model assumed an adequate water source found approximately 60 feet below ground. The well was dug to a depth of 80 feet to ensure adequate recharging capacity. In some areas of USDA Plant Hardiness Zones 5 and 6, wells would have to be drilled to much greater depths which would result in higher costs.

Selection of a well pump is crucial to the nursery operation. An electric motor was chosen because of realibility of performance, low maintenance cost and close availability of three-phase electrical power.

The third part of the irrigation syatem is the in-ground irrigation pipe. The advantages of inground water mains are: labor costs for pipe movement is eliminated, breakage due to equipment running over above ground pipe is eliminated, and lower initial cost of P.V.C. pipe compared to portable above ground

aluminum.

The fourth part of the irrigation system would be above ground and would include frost free hydrants. Three inch, portable, latchless, aluminum portable pipe was provided for irrigation within the central area. Rotating #30BH rainbird sprinklers were provided for dispersing water in the central area. A traveler gun with a dispersion rate of 450-500 gallons per minute was provided for irrigating the grow-out areas.

Enterprise Mix

We assumed that the model nursery would produce a diverse line of nursery stock. The length of the production cycle for the different species grown will vary. Five cultural groups were selected. While not all inclusive, the groups do permit a range of per unit costs to be developed as they relate to input costs and cultural factors (Table 1). For analytical purposes, we assumed that each cultural group would occupy 20% of the growing area (35 acres per group). Annual sales capacity would be 90,867 plants (Table 2). For detailed analysis, one specific plant from each group was chosen as representative of the group. While it is recognized that other plants from each category would have somewhat different requirements, it was felt that the requirements would not vary significantly in cost from the representative plant. The five groups (plant types chosen for detailed analysis are designated with a star) with some of their cultural characteristics are listed below:

Group	Plant	Cultural Characteristics
I.	SLOW GROWING EVERGREENS	
	*Taxus (species)	18-24" salable plant
	Buxus (species)	12" B&B
		10.2 sq. ft. of growing space per plant
II.	RAPID GROWING EVERGREENS	
	*Juniperus	18-24" salable plant
	chinensis (varieties)	12" B&B
	horizontalis (varieties)	10.2 sq. ft. of growing space per plant
	Pinus strobus	
	Thuja (species)	
III.	DECIDUOUS SHRUBS	
	*Viburnum (species)	18-24" salable plant
	Forsythia (species)	12" B&B
	Weigela (species)	11.9 sq. ft. of growing space per plant
	Ligustrum (species)	

IV.	SHADE TREES	
	*Acer rubrum (varieties)	2" caliper
	Acer platanoides (varieties)	24" B&B 33.6 sq. ft. of growing space per plant
	Fraxinus (species)	
	Quercus (species)	
	Tilia (species)	
	Gleditsia (species)	
V.	ORNAMENTAL TREES	
	*Malus (flowering crab) (species)	5-6' (1 1/2 - 1 3/4" caliper)
	Prunus (Ornamental plums) (species)	20" B&B 28.7 sq. ft. per plant

This mixture of plants material, would all be packaged in soil balls (balled and burlapped). Groups I, II, and III would be harvested by hand and Groups IV and V would require the assistance of a mechanical spade for harvesting.

RESULTS AND DISCUSSION

Capital Investment Requirements

Capital investment requirements for establishing field nurseries were itemized under three broad divisions: land and improvements, buildings, and machinery and equipment (Table 3). Each was further divided into several components. The nursery had an initial investment requirement of $1,379,236. Land and

land improvements represented 50% or $684,210 of the investment, buildings 12% or $165,981, and machinery and equipment 38% or $529,045.

An important consideration for managers in most industries is determination of investment per unit of production capacity. For field nurseries this indicator would be the capital requirement per-salable-plant capacity. To determine this figure it was necessary to determine how many salable plants would be produced annually for each group in its allocated 20% of the growing space. This quantity ranged from a low of 8,177 for Group IV (Acer Rubrum) to 25,418 for Group III (Viburnum). The number of plants grown per unit of space directly relates to the capital requirements per-salable-plant. These capital costs differentiated by plant group were: $15.19 for Group I (Taxus), $10.85 for Group II (Junipers), $10.16 for Group III (Viburnum), $33.73 for Group IV (Acer Rubrum), and $23.07 for group V (Malus). The average for all groups was $15.18.

Although investment requirements for a cost model field nursery for Ohio conditions were examined, an infinite number of sizes could have been analyzed. Examination of the data indicate higher investment costs per unit of salable plant capacity would incur as field nursery size is decreased from the 200 acre one analyzed. This would be caused by spreading the cost of fixed items such as buildings, equipment, and machinery over fewer units. Conversely, lower costs per unit of salable plant capacity would be realized for field nurseries larger than the

200 acre nursery analyzed as the costs of fixed items would be spread over more units.

Individual nurserymen could, of course, incur somewhat different costs than those presented. Individual costs would depend upon variables such as production cycle chosen, labor productivity and ability to bargain with suppliers. The nurseryman also may choose not to provide for future expansion, choose land that would require minimum drainage modifications, reduce optimal growing/overwintering space requirements, rent land and/or equipment, and/or operate used equipment. This analysis assumed average soil conditions, expansion capacity, optimal spacing configurations, new buildings, equipment and machinery.

SUMMARY

Production schemes were developed for five categories of ornamental crops which would represent the majority of field-grown nursery plants being produced in Ohio. Based on these production schemes, a 200 acre model field nursery was synthesized. Total capital requirements for establishing the nursery was $1,379,236. Investment per annual salable plant capacity was $15.19 for slow growing evergreens, $10.85 for fast growing evergreens, $10.16 for deciduous shrubs, $33.73 for shade trees, and $23.07 for ornamental trees.

LITERATURE CITED

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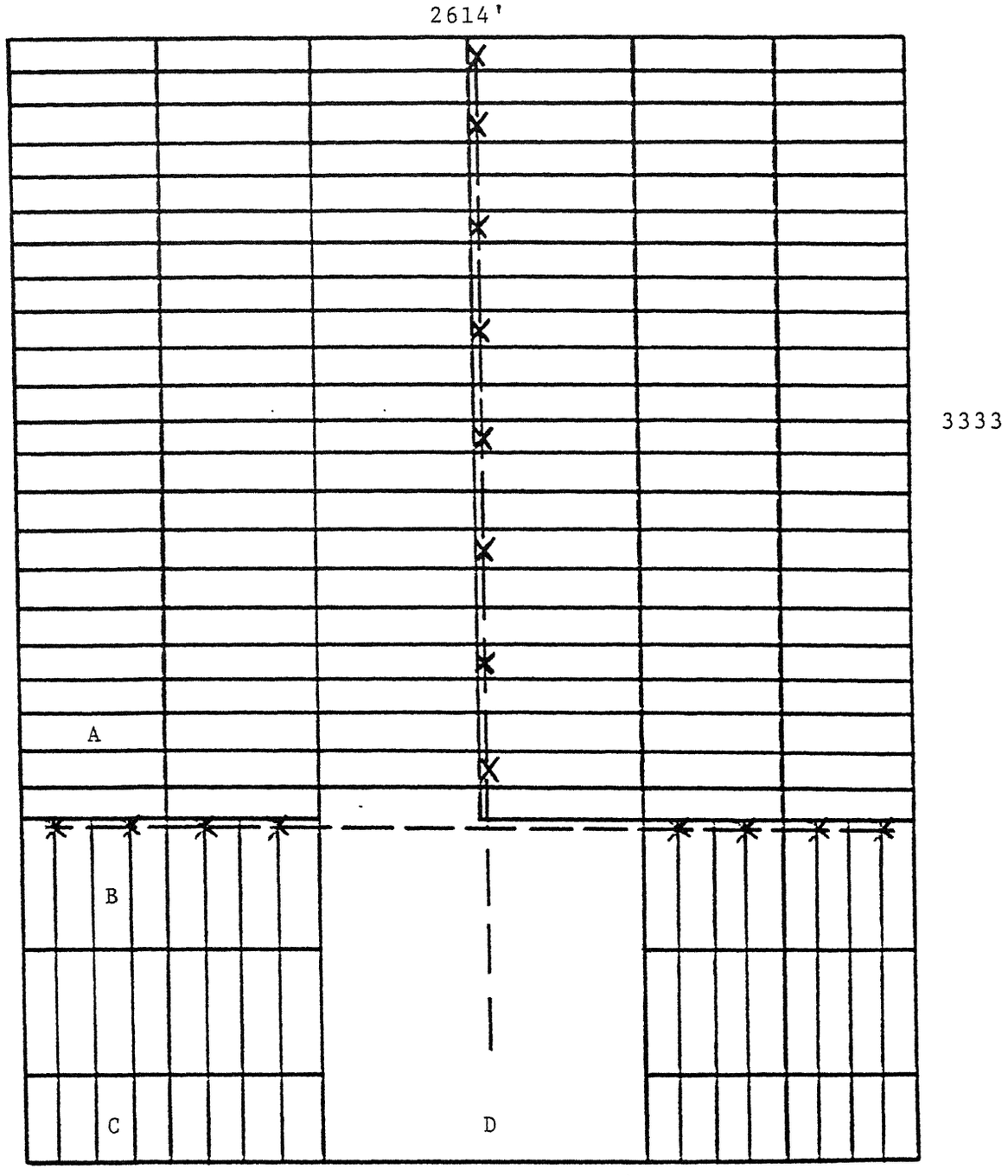
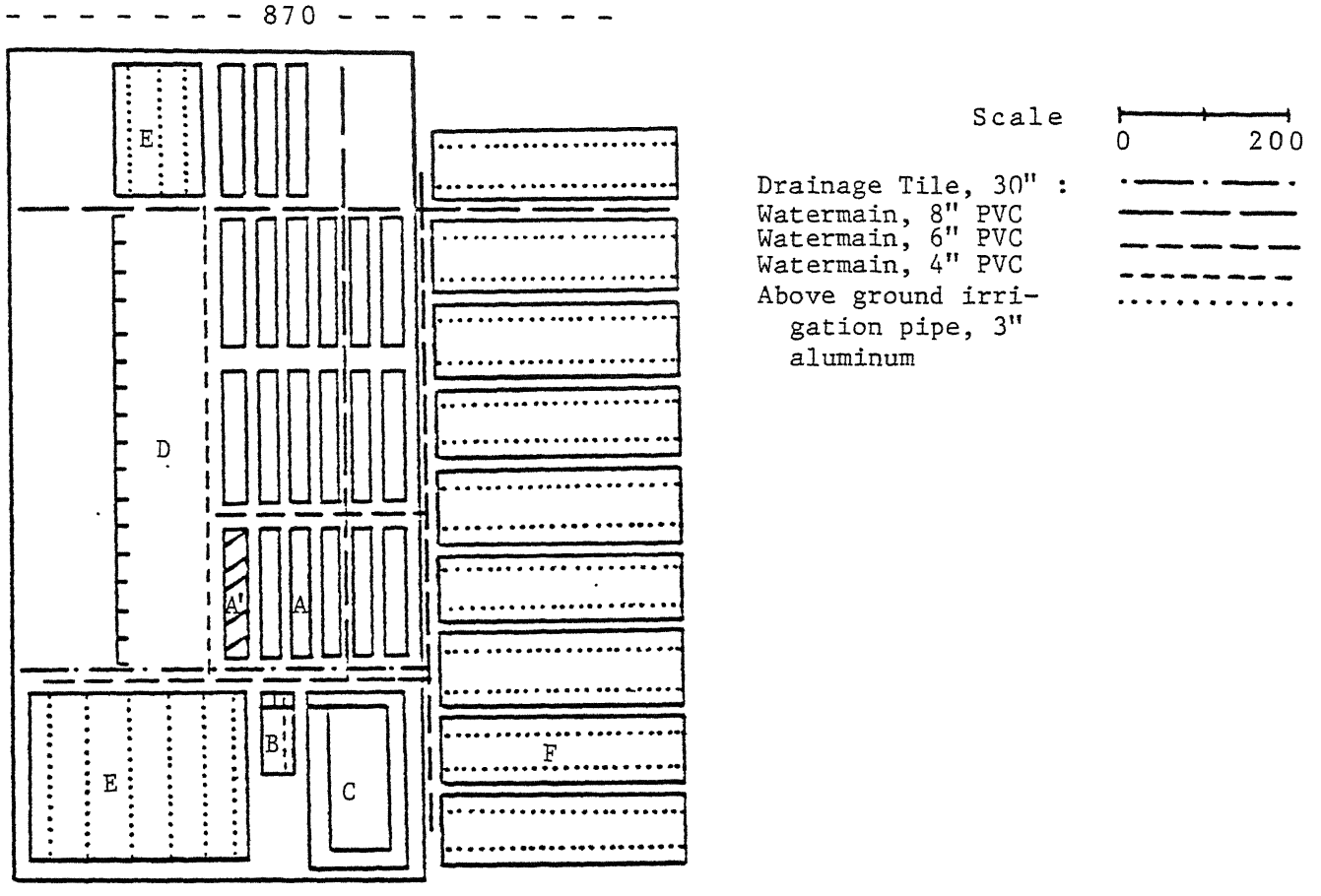
FIG. 1 - Schematic Drawing of a 200 Acre Field Nursury for Ohio



A. Growing plots (131) 100.0' x 435.6' (one acre)
B. Growing plots (32) 108.9' x 400.0' (one acre)
C. Growing plots (16) 108.9' x 300.0' (3/4 acre)
D. Production facilities, holding area, and field-bed area, 870' x 1200' (Note: one acre from this area was used as a growing plot.

X Denotes placement of water hydrants for irrigation. 8" PVC pipe —— —— ——

FIG. 2 - A schematic Drawing of a 200 Acre Field Nursery's Production Facilities, Holding Area, and Field-Bed Area for Ohio



A. Polyhouse structure, 20 each (20' x 200') = 80,000 sq. ft. = 1.84 acres
A'. Propagation house, 1 each (20' x 200') = 4,000 sq. ft. = .09 acres
B. Supply shed, machinery storage, machine shop (40' x 100')
Office and restrooms (20' x 40')
C. Pond, (80' x 220' x 14' depth), Pump house, (10' x 10')
D. Shipping area, (10 semitruck loads)
E. Holding area, (240' x 280') and
(200' x 64') = 80,000 sq. ft. = 1.84 acres
F. Liner bed area, 9 each (100' x 330') = 297,000 sq. ft. = 6.82 acres

Total Acreage, 870' x 1200' = 1,044,000 sq. ft. = 23.97 acres

TABLE 1.--Plant Densities and losses for Field Production of Nursery Plants, Ohio, 1985.

Group	Description	Size of Salable Plant	Years in Rotation	Spacing Between Rows	Spacing In Rows	Sq. Ft. Per Plant*	Plants Per Acre	Est. Percent Loss**
I	Slow Growing Evergreens - Taxus	18-24"	7	44"	28"	10.2	4,272	15
II	Fast Growing Evergreens - Juniperus	18-24"	5	44"	28"	10.2	4,272	15
III	Deciduous Shrubs - Viburnum	3-4'	4	48"	30"	11.9	3,652	15
IV	Shade Tree - Acer Rubrum	2" dia.	5	96"	42"	33.6	1,298	10
V	Ornamental Tree - Malus	5-6'(1 1/2")	4	96"	36"	28.7	1,518	10

*Sq. ft. per plant includes necessary perimeter roads.

**Assume 1/2 of loss between first and second year and remainder in last year of production. Losses in the last year of production would be left in the field.

TABLE 2.--Planting and Harvesting Requirements for a 200 Acre* Field Nursery, Ohio, 1985.

Plant Group	Description	Propagation** Units Stuck	Bedding Area*** Rooted Cuttings Planted	Field Planting Acres	Acres Planted Per Year	Units Planted Per Year	Units Harvested Per Year****
I	Slow Growing Evergreens - Taxus	37,710	26,700	35	5.00	21,360	18,156
II	Fast Growing Evergreens - Juniperus	48,594	37,380	35	7.00	29,904	25,418
III	Deciduous Shrubs - Viburnum	51,927	39,944	35	8.75	31,955	27,162
IV	Shade Tree - Acer Rubrum*****	-	-	35	7.00	9,086	8,177
V	Ornamental Tree - Malus*****	-	-	35	8.75	13,283	11,954
	Total	138,231	104,024	175	36.50	105,588	90,867

*200 total acres with 175 acres in field growing space, and 25 acres in production facilities, holding area, field bed area, roads, etc.

**For each plant available for transplanting as a rooted cutting into the bedding area, it is estimated that 1.3 cuttings would need to be stuck in the propagation facility.

***For each plant available for transplanting into the field, it is estimated that 1.25 rooted cuttings would need to be planted in the bedding area.

****Assume 1/2 dug in Fall for Fall sales and overwintering and 1/2 dug in the Spring.

*****Shade and Ornamental Trees would be purchased as bare root liners for planting directly into the field.

TABLE 3.--Capital Requirements for a 200 Acre* Field Nursery, Ohio, 1985.

Item	Description**	Unit	Useful Life (years)	Quantity	Cost per Unit (dollars)	Total Cost (dollars)	Percent of Total Cost
Land	Unimproved land	acre	--	200	2,000	400,000	29
+ Improvements	Grading, tiling, graveling, pond		20			284,210	21
Subtotal						684,210	50
Buildings							
Office and restrooms	20′ x 40′	sq ft	20	800	35	28,000	2
Plant and supply storage	40′ x 50′	sq ft	20	2000	20	40,000	3
Machinery storage and shop	40′ x 50′	sq ft	20	2000	20	40,000	3
Polyhouse structures	200′ x 20′	each	10	21	2,761	57,981	4
Subtotal						165,981	12
Machinery and Equipment							
Tractor, 100 HP	100 HP, diesel fuel	each	10	1	28,278	28,278	2
Tractor, 60 HP	60 HP, diesel fuel	each	10	1	20,419	20,419	1
Tractor, 34 HP	34 HP, gas fuel	each	10	4	14,504	58,016	4
Articulated 4-Wheel Drive Loader	Swinger 220 - Lift cap. = 2,000 lbs.	each	10	2	25,000	50,000	4
Articulated 4-Wheel Drive Loader	Swinger 320 - lift cap. = 3,000 lbs.	each	10	2	38,000	76,000	6
Tree spade	530P Handles 20",22", & 24" + liftpads	each	2	2	8,490	16,980	1
Forks	For front-end loaders	each	10	4	1,100	4,400	***
Plow	3-14 inch plows	each	10	1	2,616	2,616	***
Disk	8′ wide	each	10	1	3,900	3,900	***
Harrow	10′ wide	each	10	1	650	650	***
Cultimulcher - bed area	10′ wide	each	10	1	3,800	3,800	***
Sprayrig (boom sprayer)	100 gallon tank with 7′ & 10′ booms	each	7	1	1,407	1,407	***
Transplanter, 3 row	3-20 inch row bed transplanter	each	10	1	7,500	7,500	1
Transplanter, 1 row	Tree planter	each	10	1	5,000	5,000	***
Permanent irrigation/well pump	100HP electric pump	each	20	1	36,396	36,396	3
Inground irrigation/bed area	PVC pipe/valves		20		34,606	34,606	3
Above ground irrigation/bed area	Aluminum pipe/valves/sprinklerheads		5		4,347	4,347	***
Inground irrigation storage/holding	PVC pipe/valves		20		17,959	17,959	1
Above ground irr. storage/holding	Aluminum pipe/valves/sprinklerheads		5		8,286	8,286	1
Traveler gun - field irrigation	450-500 gallons per minute		10	1	22,000	22,000	2
Portable irrigation pump	40 HP P.T.O irrigation pump/foot valve	each	10	1	425	425	***
Airblast sprayer	Myer - 300 gallon HP on trailer	each	7	1	3,600	3,600	***
Fertilizer injector	26 gallon injector	each	5	2	858	1,716	***
Transplanter, 2 row	2-42/48" row field transplanter	each	10	1	5,600	5,600	***
U Blade - field	18" for undercutting	each	5	1	240	240	***
Undercutter - bed	Bed undercutter, 50" blade, lift tines	each	7	1	285	285	***
Fertilizer sidedresser	2 row sidedresser	each	10	1	1,000	1,000	***
Cultivator, 2 row	2 row field cultivator	each	7	2	1,750	3,500	***
Wagon	4 wheel, farm wagon	each	10	8	1,978	15,824	1
Cultivator, 3 row	3 row bed cultivator	each	7	1	2,250	2,250	***
Truck	1/2 ton pickup truck	each	5	2	13,485	26,970	2

Table 1a Cont.

Item	Description	Unit	Useful Life (years)	Quantity	Cost per Unit (dollars)	Total Cost (dollars)	Percent of Total Cost
Pallets	Wooden	each	2	482	12	5,784	***
Handtools	Miscellaneous	sets	5	76	100	7,600	1
Seeder	Broadcast Seeder		10	1	175	175	***
Mower	7′ - 3 blade mower		10	1	2,283	2,283	***
Flatbed Truck	24 ft. flatbed, gas fuel		5	1	42,000	42,000	3
Heating system for propagation							
Gas fired unit heater - Modine	200,000 BTU (input)	each	10	2	1,104	2,208	***
Fan jet - Acme		each	10	2	103	206	***
Thermostat	Two stage	each	10	2	44	88	***
Set-up for propane****	Vent., reg., etc.	each	10	2	100	200	***
Set-up for heating system	Plywood, braces, bolts, etc.	each	10	2	100	200	***
Other propagation materials						1,494	
Misting system	Mist-a-matic	each	2	6	249	494	***
Pipe and nozzles	For misting system		2	2	300	600	***
Treated boards	5/4" x 8" x variable length	foot	2	1,320	0.74	977	***
Heating cable	Propagation	foot	2	3,600	0.35	1,260	***
Subtotal						529,045	38
TOTAL						1,379,236	100

*Total Nursery - 200 acres, 175 acres of growing space, 25 acres production facilities, holding & field bed area, roads, etc.

**For details on individual items see the following tables: land improvements - Table 2; polyhouse construction - Table 3; overall irrigation system - Table 4; irrigation for winter storage and holding area - Table 4a; irrigation for bed and field - Table 4b; well and electric pump - Table 4c.

***Less than 1/2 of 1%.

****Propane tanks, connectors, etc. will be leased from the company supplying propane.